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A New Approach to Orthopaedic Implant Design

A Laboratory Directed Research and Development Proposal for Exploratory Research in the Institutes

Karin Hollerbach

Abstract

Our approach to implant design, which uses finite element modeling (FEM) of joints with implants, offers an opportunity to evaluate designs before they are manufactured or surgically implanted. This is an attractive alternative to current methods that use only experimental testing for design evaluation. Failures depend on implant and human tissue geometry, the constitutive properties of the biological and the implant materials, and/or interaction between the human tissues and the implant components. In all cases, FEM can contribute to early changes in the design process, resulting in better, less costly and longer-lasting implants.

Novel Parallel Numerical Methods for Radiation and Neutron Transport

A Laboratory Directed Research and Development Proposal for Joint Exploratory Research in the Institutes and Exploratory Research in the Directorates

Peter Brown

Abstract

The availability of advanced computational methods for transport modeling is of crucial importance to the Department of Energy and to Lawrence Livermore National Laboratory. In many of the multi-physics simulations performed at the Laboratory, transport calculations can comprise from 30-50% of the total run time. Thus, a significant core competence in the formulation, software implementation and solution of the numerical problems arising in transport modeling is an essential component of the Laboratory's computational repertoire.

The goal of the proposed research effort is to enhance these capabilities through the design of advanced numerical methods for the parallel solution of 3D radiation and neutron transport problems. The equations describing the above processes are usually some variant of the Boltzmann transport equation (BTE), which requires the solution of very large systems of equations. The ability to solve such problems efficiently requires a combination of several kinds of numerical methods for parallel computers.

Recent developments in the area of first order system least squares (FOSLS) methods show great potential for providing more accurate and robust solution procedures than current approaches. The FOSLS-based approach also provides a natural multigrid solution procedure for the resulting discretized problems. We also propose to develop more accurate phase space discretization techniques, in space and direction (angle) as well as better time-stepping algorithms is also of interest due to the absence of ray effects in spherical harmonics solutions. The harmonic projection algorithm we have developed in earlier work uses discrete-ordinates codes to obtain spherical harmonics solution, and we will investigate its usefulness in solving Laboratory problems.